MANAGEMENT OF DIABETES BY INCLUDING SOME NATURAL FACTORS AND USING UNALTERED SUCCULENT HERBS AS MEDICINE

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Diabetes

Diabetes or hyperglycemia is a physical condition that causes a rise in glucose levels in the blood higher than normal. Among the three main types of diabetes (Type 1 or childhood, type 2, and gestational), type 2 diabetes (t2d) is of the most concern. It is estimated that 439 million people around the globe would have t2d out of a total of 552 million diabetic patients in 2030 [1].

Diabetes : Reasons

The exact reasons behind the development of T2D are not very clear, but several risk factors are linked with the development of the disease among individuals.

A. Well-known risk factors

Genetics, High-calorie diet, less physical exercise, etc.

B. Less discussed reasons

Body clock violence; wrong food-drink style; irregular lifestyle; sedentary lifestyle, mental anxiety, etc.

C. Very less discussed reasons and possible reasons not listed

Deficiency of Vitamin D; improper supply of nutrients and micronutrients to the body; processed foods; intake of a mixture of synthetic chemicals **(having unknown long term cumulative and simultaneous effects)** directly as such or with food, food items and drinks, etc. as some added items [1].

Management strategies followed for control of T2D

The main management strategies followed presently is:

- Advise for **physical exercise** like attending Gym, Walking, etc.

- Advise for controlling diet by supplying **more fiber and less carbohydrates,** intake of less calorie diet, etc.

- Use of **anti-diabetic medicines**

Various pharmacological preparations (mainly chemicals of synthetic origin) are used to control the situation. These include Biguanides (Metformin), Sulfonylureas (Glipizide, Glimepiride, Glyburide, etc.), Thiazolidinediones (Pioglitazone), Alpha-glucosidase inhibitors (Miglitol, Acarbose), Non-sulfonylurea insulin secretagogues (Nateglinide, Repaglinide), Sodium-glucose cotransporter 2 (SGLT2) Inhibitors (Dapagliflozin, Canagliflozin, Empagliflozin), DPP4 Inhibitors (Alogliptin, Sitagliptin, Linagliptin, Saxagliptin), Incretin mimetic (Liraglutide, Exenatide, Dulaglutide, Lixisenatide, Albiglutide), Amylinomimetic (Pramlintide), Rapid-acting insulins (Aspart, Lispro, Glulisine, Insulin human), Short-acting insulins (Regular, NPH), Intermediate-acting insulin (Detemir), Long-acting insulins (Degludec, Glargine,), etc.

The problem areas

- Regular **increase of the dose** of these medicines is required,

- Many of these medicines have many **serious side effects**, particularly in higher doses and in continuous long-term use.

- The continuous **expenditure** on diagnosis and treatment of diabetes and it's various complications is not easily bearable by many people, particularly middle or low-income groups of people worldwide [1].

A preventive approach for the management of T2D along with many other important diseases (Primary level)

❑**Major lifestyle modifications needed**

➢Early to bed, early to rise.

➢Walking on the grasses bare-footed for at least 15 minutes daily.

➢**Direct sunbath** (on uncovered skin) for at least 20- 30 minutes at least 3 times per week.

➢Removal of salt and sugar from diet as much as possible. Honey or molasses may be used for unavoidable needs of sweetener [2].

❑**Diet Plan**:

✓Eating at a maximum of 60% of stomach capacity at a time.

✓Avoidance of high-calorie diets, red meats, ALL processed foods and chemical added drinks like bottled fruit juices, sweetened beverages, etc. (packets and bottles), Alcohol, Tobacco, and narcotics.

✓Eating of nature derived foods directly (as succulent fruits) or after traditional food preparations.

✓ Morning: Eating of succulent Turmeric (*Haldi* : *Curcuma longa*) @ 4 gms daily by chewing or making a paste X 365 days/ year.

✓Taking extracted juice (30-40 drops) of the lemon from one cup of lukewarm water (at less than 30 degrees Celsius). Then starting of morning walking.

✓Black tea/ coffee without sugar, if cannot be avoided. The added snacks may be a **Pre-mixed mixture of dry foods and nuts.**

✓Almond, Cinnamon, Raisin, Date, Flaxseed, Anjeer, Cashew, Pistachio, Apricot, Walnut, *Chia* etc. may be used in dry fruit-nut mixture [Annexure 1] [3].

A preventive approach for the management of T2D along with many other important diseases (Primary level) [Contd.]

- ✓Breakfast may be heavier than lunch.
- ✓**Pre-breakfast salad mixture**: May be prepared by Carrot, Lemon, Beet, Cucumber, Garlic, Ginger, Green chili, Onion, Ripe tomato, Radish, Lettuce, etc. [Annexure 2] [4]. It should be taken before breakfast/ lunch.
- ✓Lunch should contain less amount of easy glucose-generating carbohydrates (like rice or wheat or their products) and less animal proteins, but more amount of complex carbohydrates (as: different traditional vegetable preparations).
- ✓Water of green coconut as the refreshment drink.
- ✓Afternoon food: Mixture of different succulent fruits (Fruit salad).
- ✓Dinner time: within 8.30 to 9.30 P.M. – less calorie diet, may contain a mixture of a few pulses (dal) or may be changed every day (the same pulse cannot be eaten every day).
- ✓Night walking may be started 15 minutes after dinner for next 30 minutes.

A novel therapeutic approach for the management of T2D

Along with lifestyle modification, the succulent biomedicines can be used to manage and combat T2D

A novel therapeutic approach for the management of T2D

Procedure of production of succulent anti-diabetic biomedicines for widespread global use

[Annexure 3].

Annexure 3

Identification of the effective plants to get succulent biomedicines for the intended purpose/es

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Validation of reported activities of the medicinal plant/ plant parts by *in vivo* or in patient methods

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Standardization of dose and identification of toxicity level etc.

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Preparation of database about the main phytoconstituents present in plant parts and preparation of a standard chart of it from the available resources for each effective biomedicine

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Standardization of packaging related parameters like bio-preservatives, bio- encapsulation, spoilage indicator, etc. for each medicine

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Planning for production of the medicines at a large scale

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Cultivation of plants in their near-natural environment and soil

↓

Annexure 3 (Contd.)

Collection of succulent pant parts/fruits/dry seeds etc.

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Quality testing and calculation of quantity per dose by measuring main constituents available in each lot/ batch of raw materials by comparing with standard chart

and mixing of raw materials of different sources as per the requirement

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Preparation of pulp-paste or extraction of juice of succulent plant parts / fruits and preparation of powder of dry seeds, etc.

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Concentration or dilution of the pressure extracts (juice), mixing of a few biomedicines together, making block/capsule of powders prepared from the dry biomedicines, addition of the bio-vehicle/s with the medicines, preparation etc. (as per requirement)

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Addition of bio-preservative/ bio-coating in/on the biomedicines (as per requirement)

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Encapsulation of the medicine (pulp/juice/powder etc.) inside digestible/ harmless biological capsular materials for oral use

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Addition of spoilage indicator/s on the packets of the biomedicines (as VVM)

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Transportation through the cold chain up to the patient level

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Bringing the temperature of the medicines near to 25 ^{0}C just before use by use of warm water etc.

Essential oils of Onion, Clove, Garlic, Ginger, Cinnamon, Coriander, Mount Atlas mastic, Mint, Basil, Oregano, Rosemary, Sage, Thyme, Allspice, Mustard, Nutmeg, Vanilla, Bergamot, Eucalyptus, Lemon, *Zizyphus jujuba, Artemisia anomala, Callistemon lanceolatus,* etc. are some possible bio- preservatives for succulent biomedicines.

Detailed descriptions of various herbs, herb compounds, spices, essential oils of plants, natural substances, animal, bird and insect origin products, etc. are described and discussed in some recent publication [8].

The **concentrated juice** or the **essential oil** derived from the **same medicinal plant** of original succulent bio-medicine may be the best choice (as the essential oil of *Azadirachta indica* leaves may be used to cover the frozen *Azadirachta indica* leaf juice or pulp for preservation, if it can perform the function). These may be covering bio-preservative of the succulent bio-medicines [Annexure 7]. The next preference may be given to honey and then other bio-preservatives [9].

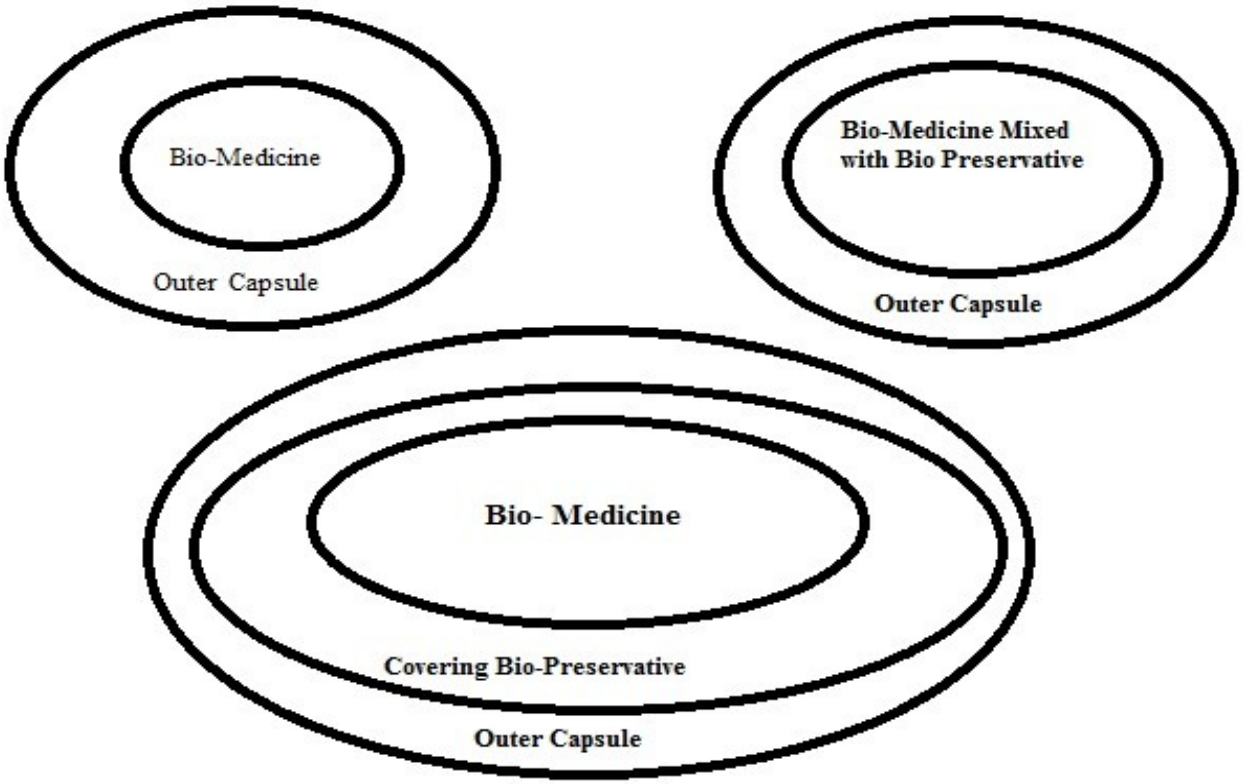
The bio-encapsulating materials for succulent bio-

Among the plant-derived materials, plant exudates (Gum Arabic, Gum karaya, Mesquite gum); plant extracts (Galactomannans, Soluble soybean, Pectin, Cocoa butter); different Starch and Cellulose derivatives, Polysaccharides; proteins like Gluten (corn), Wheat gluten, isolates of Pea or Soy; lipids like Fatty acids/ alcohols, Glycerides, Waxes (Bee wax, Candelilla wax, Carnauba wax), Shellac resin, Phospholipids are important. Among the marine origin products, Carrageenan, Alginate; animal or microbial products like Xanthan, Gellan, Dextran, Chitosan (carbohydrate), Caseins, Collagen, Corn, Whey proteins, Gelatin (protein), etc. are important [9]

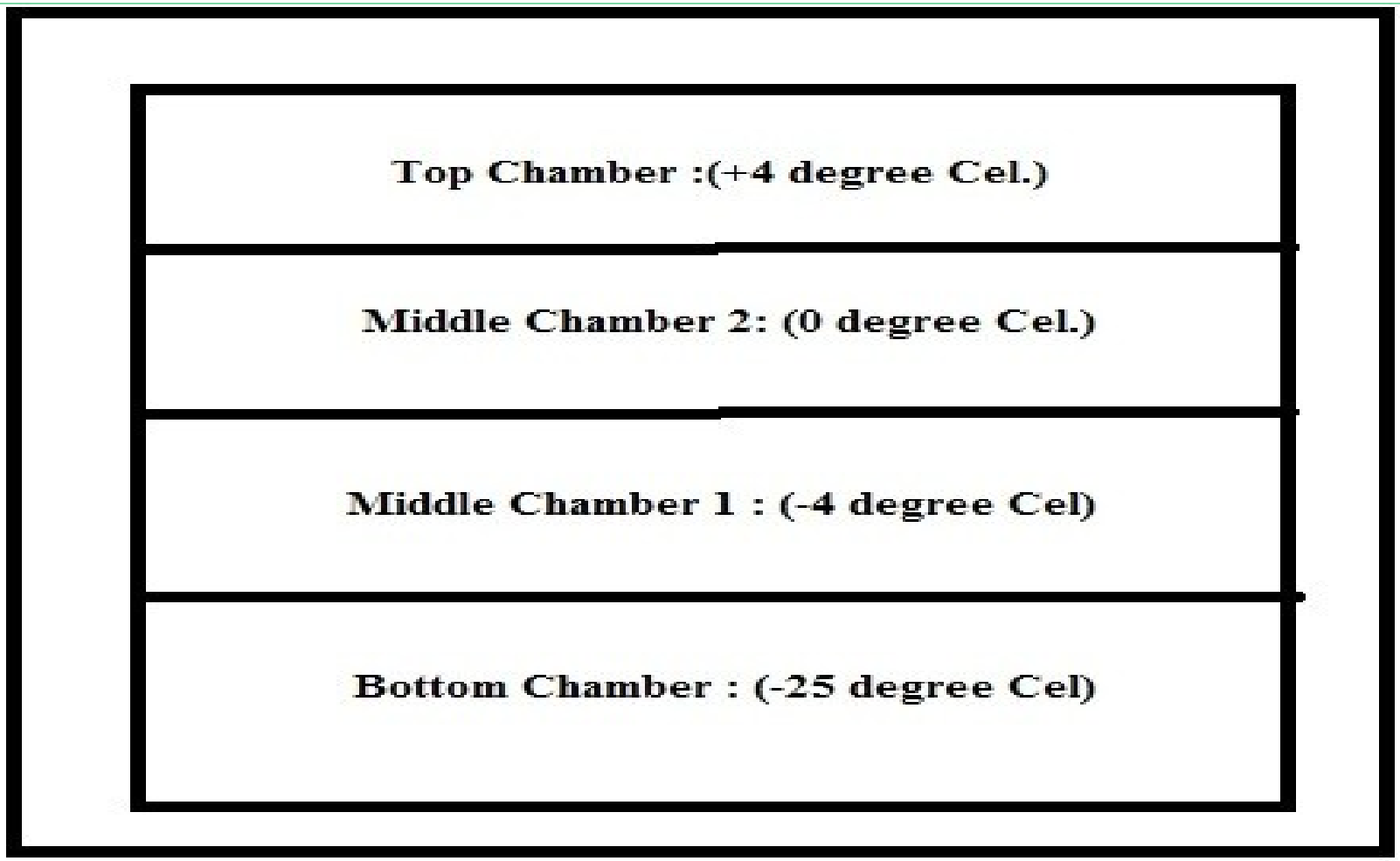
Different coating techniques, their qualities, and limitations as well as various coating materials of each group require detailed analysis before finalization [8].

At the initial stage of research, collagen or a combination of collagen and cellulose (as used in a sausage casing) and soft gel capsular materials may be considered for use [9].

Different encapsulation pattern without use of any synthetic preservative (As cross section) [1].



A sample design of storage arrangement of succulent biomedicines (Freezing Chambers) (As cross section) [1]



Prevention and cure of t2d by Succulent Biomedicines (Contd.)

❖ **Constraints and their possible solutions in implementation of the system**

✓ Validation of efficacy and determination of dose of **succulent** biomedicines should be studied directly (Contemporary researches are performed only on extracts of **dry** plant parts),

✓ There may be the problems of variation in the level of effective phyto-constituents in the same plant species grown in different conditions. But this problem can be solved by **proper mixing of raw materials (** as stated in **Annexure 3).**

✓ **Direct in patient and *in vivo*** study in place of ***in vitro*** study of isolated compounds should be given importance for these medicine **[Annexure 4].**

Annexure 4

Presently practiced pattern followed for development of modern medicines from herbal source:

Diluents extraction/ Chemical extraction/ other sources → active ingredient isolation → safety and efficacy study → proceeding towards the development of marketable medicines.

↓ Shifting

A new pattern may be followed for Succulent bio-medicines:

Succulent bio-medicines → *in vivo* and/or in-patient study for validation of efficacy → dose and safety study → chemical composition analysis (if required) → proceeding towards the development of marketable medicines.

Usable succulent herbs as some anti-t2d

A total of **(215)** anti-diabetic plants are identified and listed. Among these **(40)** plants are ready to be used in succulent conditions for prevention and treatment of diabetes without rigid toxicity study [Annexure 5, 6] [1].

- Some of these can be used mainly as preventive to T2D. (as Annexure 2).
- Some may be used mainly as curative by their indirect actions on systems (as plants described in Annexure 2)..
- But some other succulent plant parts can be used directly as curative biomedicines.
- Leaves of *Costus igneus* (Insulin plant) or *Catharanthus roseus* (Sadabahar, Nayantara) etc. are examples. But study on succulent plant part extracts of all such plants are perhaps yet to be started.

Possible mechanism of action of succulent herbal

Use of the succulent biomedicines to control and combat various diseases of infectious and non-infectious origin is **a novel concept**. The **living plant engages in various metabolic activities** and the succulent parts of the plants (fruit, stem, leaf, root, etc.) **contain a huge number of phyto-constituents, all of which act together but all may not be detectable individually by the available modern tools and techniques** [1, 10].

The attributed anti-hyperglycemic effects of the reported plants may be due to their ability **to restore the function of pancreatic tissues** and cause an increase in insulin output, **modulation of sensitivity of the tissues** to use glucose, and causing **a decrease in the intestinal absorption of glucose, etc**. So, the effects of **giving protection to the β-cells** of the pancreas along with **regulation of the fluctuation in glucose levels** inside the body can act together during the use of the anti-diabetic herbal medicines [11].

Behind such effects, the **basic influence of increase of anti-oxidation power** is mentioned in some literatures..

Nature gifted us many antioxidants in different fruits and vegetables, spices, and in many medicinal plant parts at their succulent stage.

Along with drying, frying, and boiling at high temperatures, many of them reduce in quantity to a large extent [10].

Oxygen acts as the terminal acceptor of the electron during aerobic metabolism. That oxygen then splits into single atoms with an unpaired electron and thus seeks another electron to be paired. Such single atom oxygen is termed as free radicals and the scavenging activity of these free radicals can cause many detrimental health effects inside the body. If such activities are not controlled by the supply of antioxidants, **damage or disruption of different cellular bio-molecules will be there through the production of different Reactive Oxygen Species (ROS) [12,13]**.

By incurring negative influences on different important aspects of the body like signal transduction system of the body, expression of the gene of individuals, inactivating different receptors, influencing the immune system, acting on nuclear transcription factors, aging, cytotoxic activities, *etc.*, these can cause severe harmful effects in the overall body system which may lead to easy transmission of infections, initiation of different non-infectiuos diseases, and showing more severity in the expression of disease symptoms [13,14].

The antioxidants can prevent these detrimental processes or can slow down these by removing the free radicals, thus can protect us from various diseases including diabetes.

Do we have sufficient knowledge?

From contemporary research, we already know the presence of nearly 1000 ‘carotenoids’ and over 400 flavonoids, and more than 8000 plant phenols under ‘phenolic compounds’ within known common plant resources having antioxidant activities. They are having their own mechanism to show their activities [1]!

Selective use of succulent biomedicines can supply particular antioxidants to control the targeted adverse effects and reactions of the oxidants inside the body [9].

Possible anti-diabetic effects of some natural factors

Among the **effects of nature on health**, the effect of Sunlight derived Vitamin D is a to some extent discussed topic. It is said that sunlight exposure can cause the production of vitamin D in our skin which can cause such health impacts. But only supplementation of vitamin D as some medications can not show the same effects as the sunlight exposure. The difference between the observational study reports and the result of interventional studies perhaps proves the actual effect of nature on our health, many parts of which are perhaps still not known to us [15].

Some points related with effects of Vitamin D are discussed to get some idea about it and other natural factors.

Source:

Vitamin D is synthesized from cholesterol with the assistance of Ultra Violet light of the Sun. During exposure to sunlight, 7-dehydrocholesterol in the skin absorbs UV-B (action spectrum 280–320nM) radiation and is converted to vitamin D3 which in turn isomerizes into vitamin D3. It is also available in some foods, like sea fish, egg yolk, and some fortified foods.

Another source of Vitamin D is mushrooms. A similar process takes place in plants and mushrooms, where UV-B light leads to the formation of vitamin D2 from ergosterol, a compound found in plants.

Activities:

Along with its effects on regulating the amount of calcium and phosphate in the body and promoting bone, teeth, and muscle development, vitamin D deficiency is linked with health disorders **from hair loss to the development of prostate cancer, depression, diabetes, and rheumatoid arthritis. Reduction of body immunity power, disrupting the metabolism** of the body, incurring

Vitamin D : Deficiency level in India

All-India data on Vitamin D levels based on analysis of 2.2 lakh samples between March-August 2022 [5,6].	
Gender	Percentage
Male	79%
Female	75%
Age group	Percentage
Below 25 years	84 %
25 – 40 years	81%

So, 3 out of 4 Indians Suffer from Vitamin D Deficiency. **Young adults below 25 years of age are the most affected segment!**

Vitamin D : Effects on T2D

Vitamin D deficiency

- Acts on both the initial insulin resistance and the subsequent onset of diabetes caused by β-cell death.

- It also acts to increase inflammations, which are a major process in inducing insulin resistance [7].

Effects of other lifestyle and natural factors

✓The practice of Yoga and alike procedures can also assist in relaxation from mental stress [15, 16].

✓Morning and/or afternoon walking at the park or any space with green plants and trees can assist in the prevention or delay development as well as reduction of severity of many diseases including diabetes.

✓There is scientific evidence of reduction of risk of development of diabetes as well as reduction of risk of development of obesity in the section of common people visit green spaces regularly [16].

The presence of a good level of vitamin D in the blood and avoidance of stress and other related psychosocial variables can also act to prevent the initiation and magnitude of diabetes [17,18].

1. Along with **addition of some factors of nature** and **some succulent biomedicines at their natural form in the diet**, T2D can be managed to a large extent. These steps may not require any thorough research.

2. For total management of T2D, specific research for standardization of dose of the already known non-toxic succulent biomedicines by performing some activity – based study may be the practical option of present time (40 plants are listed for that purpose).

Detailed study on all other listed plants may be performed then (another 165 plants are listed for that purpose).

3. The succulent biomedicines for anti-diabetic use **may be prepared, encapsulated and transported** for their effective use throughout the globe up to the consumer/ patient level without addition of any synthetic chemicals with them at

Conclusion (Contd.)

4. The succulent biomedicines will act in a far better way in a favorable environment inside our body system.

So, identification of lifestyle-related lacunae and their correction is needed for getting the highest level of activities of these biomedicines.

NOW

5. **Medicines are known, basic manufacturing process is identified; the time has come for involvement of the researchers and entrepreneurs to perform adoptive research for manufacturing and marketing the anti-diabetic succulent bio-medicines.**

Annexure 1

Almond *(Prunus amygdalus)* 5-6 pcs
Cinnamon (*Cinnamomum verum*) 2-3 gm
Raisin *(Vitis vinifera)* 8-10 pcs
Date (*Phoenix dactylifera*) 2-3
Flaxseed *(Linum usitatissimum)* 3-4 gm
Anjeer (*Ficus carica* L.) 1-2 pc
Cashew (*Anacardium occidentale*) 3-4 pcs
Pistachio (*Pistacia vera*) 4-5 pcs
Apricot (*Prunus armeniaca* 2-3 pcs
Walnut (*Juglans regia*) 1-2 pcs
Chia seed (*Salvia hispanica)* 2-3gm, etc.
(Approximate figure/ per day for each adult person is stated)

Annexure 2

Turmeric (*Curcuma longa*) 5 gm Separately
Lemon (*Citrus limon*) 80-150 drops Separately
Carrot (*Daucus carota* subsp. *Sativus*) 5-10 gm.
Beet (*Beta vulgaris*) 5-10 gm
Cucumber (*Cucumus sativus*) 15-20 gm
Garlic (*Allium sativum*) 2-3 pc
Ginger (*Zingiber officinale*) 2-3 gm
Green chili (*Capsicum frutescens*) (1 pc, @2-3 gm)
Onion (*Allium cepa*) 5-10 gm
Ripe tomato (*Solanum lycopersicum*) 5-10 gm
Radish (*Raphanus sativus*) 3-5 gm
Lettuce (*Lactuca sativa*) leaf 2-3 gm
(Approximate figure/ per day for each adult person is stated)

Abelmoschus esculentus L. (Moench). [Malvaceae], *Abroma augustum* (L.) L.f. [Malvaceae], *Acacia arabica* (Lam.) Willd.[Fabaceae], *Acacia senegal* (L.) Willd. [Fabaceae], *Acanthopanax senticosus* (Rupr. & Maxim.) Harms [Araliaceae], *Achyranthes aspera* L. [Amaranthaceae], *Acorus calamus* L. [Acoraceae], *Adansonnia digitata* L. [Malvaceae], *Agrimonia eupatoria* L. [Rosaceae], *Alangium lamarckii* Thwaites [Cornaceae], *Albizia odoratissima* (L.f.) Benth. [Fabaceae], *Allium cepa* L. [Amaryllidaceae], *Aloe sinkatana* Reynolds [Asphodelaceae], *Aloe vera* (L.) Burm.f.. [Asphodelaceae], *Ambrosia maritima* L. [Asteraceae], *Ammi visnaga* (L.) Lam. [Apiaceae], *Anacardium occidentale* L. [Anacardiaceae], *Ananas comosus* L. (Merr.) [Bromeliaceae], *Annona muricata* L. [Annonaceae], *Annona squamosa* L. [Annonaceae], *Areca catechu* L. [Arecaceae], *Alstonia scholaris* (L.) R.Br [Apocynaceae], *Axonopus compressus* (Sw.) P.Beauv. [Poaceae], *Bacopa monnieri* (L.) Pennell [Plantaginaceae], *Balanites aegyptiaca* (L.) Del. [Zygophyllaceae], *Bauhinia rufescens* Lam. [Fabaceae], *Bauhinia forficata* Link. [Fabaceae], *Berberis aristata* DC. [Berberidaceae], *Berberis vulgaris* L. [Berberidaceae], *Benincasa hispida* (Thunb.) Cogn. [Cucurbitaceae], *Biophytum sensitivum* (L.) DC. [Oxaildaceae], *Boerhaavia diffusa* L. [Nyctaginaceae], *Bougainvillea spectabilis* Willd. [Nyctaginaceae], *Brassssica juncea* (L.) Czern. [Brassicaceae], *Bridelia ndellensis* Beille. [Phyllanthaceae], *Bruguirea gymnorrhiza* (L.) Lam. [Rhizoporaceae], *Butea monosperma* (Lam.) Taub. [Fabaceae], *Caesalpinia bonducella* (L.) Fleming NJJ [Fabaceae], *Caesalpinia digyna* Rottler [Fabaceae], *Cajanus cajan* (L.) Millsp. [Fabaceae], *Calotropis gigantea* (L.) Dryand. [Apocynaceae], *Canavalia ensiformis* (L.) DC. [Fabaceae], *Capparis decidua* (Forssk.) Edgew. [Capparaceae], *Caralluma sinaica* (Decaisne) A. Berger [Apocynaceae], *Carica papaya* L. [Caricaceae], *Carthamus tinctorius* L. [Asteraceae], *Casearia esculenta* Roxb.[Flacourtiaceae], *Cassia kleinii* Wight & Arn. [Caesalpiniaceae], *Cassia auriculata* L. [Caesalpiniacae], *Centaurium erythrea* Rafn [Gentianaceae], *Catunaregam nilotica* (Stapf) Tirven [Rubiaceae], *Centella asiatica* (L.) Urb. [Apiaceae], *Chaenomeles sinensis* (Thouin) Koehne [Rosaceae], *Cicer arietinum* L.[Fabaceae], *Cichorium intybus* L. [Asteraceae], *Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm. [Lauraceae], *Cocculus hirsutus* (L.) Diels [Menispermaceae], *Cocos nucifera* L. [Arecaceae], *Combretum micranthum* G. Don [Combretaceae], *Coriandrum sativum* L. [Apiaceae], *Coscinium fenestratum* Colebr. [Menispermaceae], *Costus speciosus* (J.Koenig) Sm. [Costaceae], *Cyclocarya paliurus* (Batalin) Iljinsk. [Juglandaceae], *Cynodon dactylon* (L.) Pers. [Poaceae], *Dendrobium chrysotoxum* Lindl. [Orchidaceae], *Dillenia indica* L. [Dilleniaceae], *Dioscorea dumetorum* (Kunth) Pax [Dioscoreaceae], *Dregea volubilis* (L. f.) Benth. ex Hook. f.,[Apocynaceae], *Elephantopus scaber* L. [Asteraceae], *Enicostemma littorale* Blume [Gentianaceae], *Eucalyptus globulus* Labill. [Myrtaceae], *Faidherbia albida* (Delile) A. Chev. [Fabaceae], *Ferula assa-foetida* L. [Apiaceae], *Ficus benghalensis* L. [Moraceae], *Ficus hispida* L. [Moraceae], *Ficus racemosa* L. [Moraceae], *Ficus religiosa* L. [Moraceae], *Geigeria alata* (Hochst. & Steud. ex DC.) Oliv. & Hiern [Asteraceae], *Glinus oppositifolius* (L.) Aug.DC. [Molluginaceae], *Guazuma ulmifolia* Lam. [Malvaceae], *Guiera senegalensis* J.F.Gmel. [Combretaceae], *Helicteres isora* L. [Malvaceae], *Hibiscus rosa sinensis* L. [Malvaceae], *Holarrhena pubescens* Wall. ex G.Don [Apocynaceae], *Hybanthus enneaspermus* L. (F.

Ichnocarpus frutescens (L.) W.T.Aiton [Apocyanaceae], *Ipomoea batatas* (L.) Lam. [Convolvulaceae], *Jatropha curcas* L. [Euphorbiaceae], *Justicia adhatoda* L. [Acanthaceae], *Kaempferia parviflora* Wall. ex Baker [Zingiberaceae], *Khaya senegalensis* (Desr.) A. Juss. [Meliaceae], *Kigelia africana* (Lam.) Benth [Bignoniaceae], *Lantana camara* L. [Verbanaceae], *Lawsonia inermis* L. [Lythraceae], *Lippia nodiflora* (L.) Michx. [Verbenaceae], *Liriope spicata* (Thunb.) Lour. [Asparagaceae], *Lupinus albus* L. Subsp. *termis* (Forsk.) Ponert. [Fabaceae], *Mangifera indica* L. [Anacardiaceae], *Melia azedarach* L. [Meliaceae], *Mitragyna inermis* (Willd.) Kuntze [Rubiaceae], *Mollugo pentaphylla* L. [Molluginaceae], *Momordica charantia* L. [Cucurbitaceae], *Marrubium vulgare* L. [Lamiaceae], *Morus alba* L.[Moraceae], *Mucuna pruriens* (L.) DC. [Fabaeae], *Murraya koenigii* (L.) Sprengel [Rutaceae], *Musa paradisiaca* L. [Musaceae], *Musa sapientum* L. [Musaceae], *Nauclea latifolia* Smith [Rubiaceae], *Nigella sativa* L. [Ranunculaceae], *Opuntia ficus-indica* (L.) Mill. [Cactaceae], *Opuntia streptacantha* Lam. [Cactaceae], *Ophiopogon japonicus* (Thunb.) Ker Gawl. [Asparagaceae], *Ougeinia oojeinensis* (Roxb.) Hochr. [Fabaceae], *Panax ginseng* C.A.Mey.[Araliaceae], *Parinari excelsa* Sabine [Chrysobalanaceae], *Perilla frutescens* (L.) Britton [Lamiaceae], *Phyllanthus reticulates* Poir. [Phyllanthaceae], *Polyalthia longifolia* (Sonn.) Thwaites [Annonaceae], *Posidonia oceanica* (L.) Delile [Posidoniaceae], *Prosopis glandulosa* Torr. [Fabaceae], *Psidium guajava* L. [Myrtaceae], *Pterocarpus marsupium* Roxb. [Fabaceae], *Punica granatum* L. [Lythraceae], *Rhynchosia minima* (L.) DC. [Fabaceae], *Ricinus communis* L. [Euphorbiaceae], *Rubia cordifolia* L. [Rubiaceae], *Rumex patientia* L. [Polygonaceae], *Salvadora oleoides* Decne [Salvadoraceae], *Salacia chinensis* L. [Celastraceae], *Salacia macrosperma* Wight [Celastraceae], *Salvia nemorosa* L. [Lamiaceae], *Salvia officinalis* L. [Lamiaceae], *Saraca asoca* (Roxb.) Willd [Fabaceae], *Sarcopoterium spinosum* (L.) Spach [Rosaceae], *Sclerocarya birrea* (A. Rich.) Hochst [Anacardiaceae], *Securinega virosa* Roxb (Ex Willd) Baill. [Euphorbiaceae], *Selaginella tamariscina* (P. Beauv.) Spring [Selaginellaceae], *Semecarpus anacardium* L.f. [Anacardiaceae], *Senna auriculata* (L.) Roxb. [Fabaceae], *Senna obtusifolia* (L.) H.S. Irwin & Barneby [Fabaceae], *Sesamum indicum* L. [Pedaliaceae], *Setaria italica* (L.) P. Beauvois [Poaceae], *Sida cordifolia* L. [Malvaceae], *Smallanthus sonchifolius* (Poepp.) H. Rob. [Asteraceae], *Solanum torvum* Sw. [Solanaceae], *Solanum xanthocarpum* Schrad. [Solanaceae], *Striga hermonthica* (Delile) Benth. [Orobanchaceae], *Strychonous potatorum* L.f. [Loganiaceae], *Symplocos coccinea* Humb. & Bonpl. [Symplocaceae], *Symplocos cochinchinensis* (Lour.) S.Moore [Symplocaceae], *Swertia punicea* Hemsl. [Gentianaceae], *Terminalia bellirica* (Gaertn.) Roxb. [Combretaceae], *Terminalia catappa* L. [Combretaceae], *Tinospora bakis* (A.Rich.) Miers [Menispermaceae], *Urtica dioca* L. [Urticaceae], *Vaccinium bracteatum* Thunb. [Ericaceae], *Vangueria madagascariensis* J.F. Gmel. [Rubiaceae], *Vernonia anthelmintica* (L,) Willd.[Asteraceae], *Vitex negundo* L. [Lamiaceae], *Viscum schimperi* Engl. [Viscaceae], *Wrightia antidysenterica* (L.) R.Br. [Apocynaceae], *Zygophyllum album* L.f. [Zygophyllaceae], *Zygophyllum coccineum* L. [Zygophyllaceae],

Aegle marmelos L. [Rutaceae], *Allium sativum* L. [Amaryllidaceae], *Andrographis paniculata* (Burm.f.) Nees. [Acanthaceae], *Annona squamosa* L. [Annonaceae], *Azadirachta indica* A. Juss. [Meliaceae], *Bauhinia purpurea* L. [Fabacerae], *Beta vulgaris* L. [Amaranthaceae], *Catharanthus roseus* (L.) G. Don. [Apocynaceae], *Cinnamomum verum* J. Presl. [Lauraceae], *Citrullus colocynthis* (L.) Schrad. [Cucurbitaceae], *Coccinia grandis* (L.) Voigt**.** [Cucurbitaceae], *Costus igneus* N.E.Br. [Costaceae], *Curcuma longa* L. [Zingiberaceae], *Cyperus rotundus* L. [Cyperaceae], *Daucus carota* subsp. *sativus* var. atrorubens Alef. [Apiaceae], *Emblica officinalis* Gaertn. [Phyllanthaceae], *Embelia ribes* Burm. f. [Primulaceae], *Foeniculum vulgare* Mill. [Apiaceae], *Gymnema sylvestre* R. Br. [Apocynaceae], *Hemidesmus indicus* (L.) R. Br. [Apocynaceae], *Hibiscus sabdariffa* L. [Malvaceae], *Lithocarpus polystachyus* Wall. ex A.DC. [Fabaceae], *Momordica balsamina* L. [Cucurbitaceae], *Moringa oleifera* Lam. [Moringaceae], *Ocimum sanctum* L. [Lamiaceae], *Picrorrhiza kurroa* Royle ex Benth. [Plantaginaceae], *Piper cubeba* L.f. [Piperaceae], *Piper longum* L. [Piperaceae], *Piper nigrum* L. [Piperaceae], *Salvia hispanica* L. [Lamiaceae], *Smilax aspera* L. [Smilacaceae], *Swertia chirayita* (Roxb.) H.Karst. [Gentianaceae], *Syzyguim cumini* (L.) Skeels. [Myrtaceae], *Terminalia chebula* Retz. [Combretaceae], *Trigonella foenum-graecum* L. [Fabaceae], *Tinospora cordifolia* (Thunb.) Miers. [Menispermaceae], *Vaccinium arctostaphylos* L**.** [Ericaceae], *Vernonia amygdalina* Delile. [Asteraceae], *Zingiber officinale* Roscoe. [Zingiberaceae], *Zingiber zerumbet* (L.) Roscoe ex Sm. [Zingiberaceae]

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